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Many financial advisors and much of the academic literature often argue that young people should place most of their savings in stocks. In contrast, a significant fraction of U.S. households do not hold stocks. Investors typically hold very little in stocks when they are young, progressively increase their holdings as they age, and decrease their exposure to stock market risk when they approach retirement. The authors show how long-run labor income risk helps explain this evidence. Moreover, they discuss the effect of long-run labor income risk on the valuation of pension plan obligations, their funding, and the allocation of pension assets across different investment classes.

Preannounced tax cuts and their potential influence on the 2001 recession
R. Andrew Butters and Marcelo Veracierto

The authors present a model in which anticipated future tax cuts, like those promised during the 2000 U.S. presidential campaign, generate a contraction in economic activity with some of the atypical features observed during the 2001 recession (such as its relatively strong consumption and home investment).
Investing over the life cycle with long-run labor income risk

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**Introduction and summary**

Throughout life, people make saving and spending decisions. Moreover, they choose how to allocate their savings among assets that have predictable but low returns, like bonds, and assets that are riskier but could yield higher returns, like stocks. Choices that are made when individuals are relatively young will have large implications for their standard of living in retirement, when much of their income is likely to come from savings. Private pension plans and the Social Security system face similar decisions about how best to invest assets for their clients.

Financial advisors and much of the academic literature often argue that it is optimal for young investors to place most of their savings in stocks, which historically have paid a high risk premium relative to low-risk bonds like Treasuries, and to switch their holdings to less risky securities as they age. For instance, Malkiel (1996) recommends that investors place (100 – age)% of their financial wealth in a well-diversified portfolio of stocks. In contrast, empirical evidence shows that a significant fraction of U.S. households do not hold stocks. Moreover, life-cycle stock holdings are “hump-shaped”: Investors typically hold very little in stocks when they are young, progressively increase their holdings as they age, and decrease their exposure to stock market risk when they approach retirement (for example, Ameriks and Zeldes, 2004; and Campbell, 2006). This empirical evidence is commonly referred to as the “limited stock market participation” puzzle.

In this article, which draws on work by Benzoni, Collin-Dufresne, and Goldstein (2007), we discuss how long-run labor income risk helps to explain the limited stock market participation puzzle. We argue that the correlation in labor income flows and stock market returns is a positive function of the investment horizon. At long horizons, labor income and stock market returns are likely to move together, mirroring changes in the broader economy. However, at shorter horizons idiosyncratic events lower the correlation between labor income flows and stock returns. When a worker is young and has her entire career ahead of her, the first effect prevails. Thus, she prefers to buy risk-free bonds rather than risky stocks to compensate for the risk of possible long-run fluctuations in her labor income. This outcome is consistent with empirical observation: As mentioned previously, there is little participation in the stock market among young American households.

To better convey the intuition for this result, it is useful to introduce the notion of “human capital,” which is broadly defined as the set of knowledge, skills, health, and values that contribute to making workers productive (for example, Becker, 1964; and Rosen, 2008). A measure of a worker’s human capital is the present value of her future labor income flows. When the worker is young, human capital dwarfs financial wealth on hand. Thus, the properties of human capital wealth will have a significant impact on her investment decisions.

At the beginning of her career, a worker is highly exposed to long-run labor income risk. Because of this effect, a significant fraction of her human capital is implicitly tied up in the stock market; that is, the present value of future labor income flows acquires “stock-like” properties. The worker cannot get rid of this forced investment in stocks, since any contract written against future labor services is not strictly enforceable (labor income is a nontraded asset). Thus, the young worker...
finds herself overexposed to stock market risk. To compensate for this effect, she places her financial wealth in a risk-free bond, rather than buying stocks.

When the worker ages, she is less exposed to long-run labor income risk. As a result, the fraction of her human capital implicitly tied up in the stock market declines; that is, the stock-like properties of human capital are attenuated. This effect reduces the worker’s overall exposure to stock market risk. Thus, she finds it optimal to place a larger fraction of her financial wealth in stocks, resulting in the upward sloping part of the life-cycle portfolio holding profile.

Finally, as the worker grows older, two counteracting effects are at play. Since the investment horizon is short, long-run labor income risk fades away. As such, the worker’s human capital attains “bond-like” properties, in turn increasing the demand for stocks. However, the number of years left to work goes down, and human capital shrinks, which pushes the ratio of human capital to financial wealth to zero. When that happens, labor income no longer affects portfolio choice and the demand for stocks goes down. As the worker approaches retirement, the second effect dominates, resulting in the downward sloping portion of the life-cycle profile.

The rest of the article proceeds as follows. We first present stylized evidence on the relation between stock holdings and age. In the next two sections we outline the Benzoni, Collin-Dufresne, and Goldstein (2007) labor income model and compare it with other specifications previously considered in the literature. The following section gives intuition for the model and its implications for a worker’s life-cycle stock holdings. Next, we discuss the role of long-run labor income risk in other applications that are at the center of a heated debate among financial, political, and academic circles: the valuation of pension plan obligations, their funding, and the allocation of pension assets across different investment classes. We conclude the article with some ideas for future work.

The limited stock market participation puzzle

Over the years, participation in the stock market by Americans has increased considerably. Still, a vast number of U.S. households do not hold stocks, either directly (for example, through direct holdings of publicly traded stocks) or indirectly (for example, through investment in mutual funds; individual retirement accounts, or IRAs; or other retirement accounts). Figure 1 illustrates this claim using data from the Federal Reserve Board’s Survey of Consumer Finances (SCF), while the appendix provides a brief description of the data.

The plots show that a very small fraction of young investors have been holding stocks in the past decade. The participation rate is higher for middle-age households and declines for older investors.

Moreover, the share of financial assets placed in stocks is typically low when investors are young, it increases with age, and then it decreases when individuals approach retirement. This pattern is illustrated in figure 2 for the years 1998, 2001, 2004, and 2007. The plots show the median share of stock holdings, computed as a fraction of financial assets, for U.S. households in different age brackets. They are in stark contrast to the recommendations of many financial advisers who suggest investors should place (100 – age)% in stocks (also shown in figure 2).

There may be a legitimate concern that this evidence is biased by the financial decisions of less affluent investors, who own little financial assets and therefore prefer to keep their limited savings in low-risk securities. However, figure 3 (p. 6) shows that the share of financial assets invested in stocks for households participating in the stock market remains low. Moreover, figure 4 (p. 7) depicts stock market participation rates and stock holdings for 2007, broken down by groups of investors holding different amounts of financial assets. The plots show that even the richest households are reluctant to participate in the stock market when they are young (panel A) and their stock holdings are very low (panel B).

Of course, other factors affect individuals’ investment decisions besides age and financial wealth. We do not pursue a more formal analysis here and instead point the interested reader to the vast empirical literature that has studied life-cycle investment decisions (see Ameriks and Zeldes, 2004; Campbell, 2006; Faig and Shum, 2002; Haliassos and Bertaut, 1995; Heaton and Lucas, 2000; Poterba and Samwick, 2001; Wachter and Yogo, 2009; and many others). It is difficult to reconcile the findings of all these studies because of differences in sample period, data sources, and assumptions. The main conclusions of these papers are, however, largely consistent with the stylized evidence presented here. For instance, Campbell (2006) documents a great deal of stock market nonparticipation, even among rich households, and finds hump-shaped life-cycle stock holdings, with a peak when the agent is in her late fifties.

A model of long-run labor income risk

A vast literature has examined the empirical properties of labor income using household-level data—for example, Carroll and Samwick (1997); Cocco, Gomes, and Maenhout (2005); Gomes and
Michaelides (2005); Gourinchas and Parker (2002); and Jagannathan and Kocherlakota (1996). These studies generally agree that the flow of labor income has three salient components. First, there is an aggregate stochastic component that captures the effect of economy-wide shocks on total workers’ compensation. Second, there is an idiosyncratic stochastic component subject to individual-specific shocks. Third, there is an idiosyncratic deterministic component due to lifecycle predictability in wages.

More specifically, this literature concurs that the (logarithmic) household-level labor income, $\ell$, is well approximated by the sum of an aggregate and an idiosyncratic term,

$$1) \quad \ell = \ell_1 + \ell_2.$$ 

The idiosyncratic term $\ell_2$ embeds both stochastic and deterministic components. The idiosyncratic shocks have both transient and persistent features, and the persistent shocks are well characterized by a unit-root process. Moreover, there is compelling evidence that the deterministic life-cycle labor income profile is hump-shaped; that is, on average, labor income is low when a worker is young, increases as she advances in her career, and tends to decrease as she approaches retirement.

In contrast, the properties of the aggregate labor income term $\ell_1$ are more controversial. There is an ongoing debate regarding the linkage between the performance of the stock and labor markets. Contemporaneous correlations between aggregate labor income shocks and stock market returns are typically found to be low or zero. Prior studies have examined the implications of this property for life-cycle portfolio

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**FIGURE 1**

U.S. households holding stocks: Empirical evidence

<table>
<thead>
<tr>
<th>A. 1998</th>
<th>B. 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>percentage of households holding stocks</td>
<td>percentage of households holding stocks</td>
</tr>
<tr>
<td><img src="image1" alt="Graph A. 1998" /></td>
<td><img src="image2" alt="Graph B. 2001" /></td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>C. 2004</th>
<th>D. 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>percentage of households holding stocks</td>
<td>percentage of households holding stocks</td>
</tr>
<tr>
<td><img src="image3" alt="Graph C. 2004" /></td>
<td><img src="image4" alt="Graph D. 2007" /></td>
</tr>
</tbody>
</table>

choice—for example, Campbell et al. (2001); Cocco, Gomes, and Maenhout (2005); Davis and Willen (2000); Gomes and Michaelides (2005); Haliassos and Michaelides (2003); and Viceira (2001). This literature concurs that, in spite of labor income risk, a young investor should place much of her financial wealth in the risky asset. This result holds because in these models labor income shocks are assumed to be (nearly) independent from stock market return innovations. Thus, a young investor chooses to diversify away her human capital risk by holding a high fraction of her liquid wealth invested in a well-diversified portfolio of stocks.

These models, however, also restrict long-run correlations between aggregate labor income and stock market shocks to be low or zero. This restriction is controversial. For instance, it is natural to conjecture that a sustained period of high economic growth will result in strong stock and labor market performance over the long run. Along these lines, Baxter and Jermann (1997) argue that aggregate labor income and economic growth, measured as gross domestic product (GDP) growth, are co-integrated, while Benzoni, Collin-Dufresne, and Goldstein (2007) provide evidence that aggregate labor income and dividends on the stock market portfolio are co-integrated.
Here we focus on the Benzoni, Collin-Dufresne, and Goldstein (2007) model. We specify the dividend process $D(t)$ on the stock market portfolio to follow a geometric Brownian motion,

$$dD = g_Ddt + \sigma dz.$$  

Ito’s lemma gives the dynamics for the logarithmic dividend process $d(t) \equiv \log[D(t)]$,

$$d\log(D) = \left( g_D - \frac{\sigma^2}{2} \right) dt + \sigma dz.$$  

Assuming that the pricing kernel has a constant drift equal to the risk-free rate and a constant market price for risk, the return on the investment strategy $S(t)$ that reinvests all proceeds (dividends and capital gains) in the stock market portfolio is:

$$ds = \left( \mu - \frac{\sigma^2}{2} \right) dt + \sigma dz,$$

where $s(t) \equiv \log[S(t)]$ and $\mu$ is the total expected rate of return of the investment strategy.

In this simple model, the dividend growth rate volatility $\sigma$ is identical to the stock return volatility. This is counterfactual (stock returns fluctuate more

### FIGURE 3

**Life-cycle stock holdings for stockholders: Empirical evidence**

**A. 1998**  
percentage of financial assets in stocks

**B. 2001**  
percentage of financial assets in stocks

**C. 2004**  
percentage of financial assets in stocks

**D. 2007**  
percentage of financial assets in stocks

Notes: The blue lines show the median percentage of stock holdings, computed as a share of financial assets, for U.S. households holding stocks. The black lines show the life-cycle stock holdings for a strategy that invests $(100 - \text{age})\%$ of financial assets in stocks.  

than dividends), but inconsequential for life-cycle portfolio decisions as long as \( \sigma \) is calibrated to match historical stock return volatility.

To capture the notion of long-run dependence between aggregate labor income flow and dividends, Benzoni, Collin-Dufresne, and Goldstein (2007) introduce a variable \( y \) that measures the (logarithmic) difference between these two variables,

\[
y(t) = \ell_1(t) - \hat{d}(t) - \ell_{d},
\]

where the constant \( \ell_{d} \) is the long-run logarithmic ratio of aggregate labor income to dividends. They assume that \( y(t) \) is a mean-reverting process,

\[
\dot{y}(t) = -\kappa y(t) dt + \nu_1 dz_1(t) - \nu_3 dz_3(t),
\]

where \( z_1 \) is a standard Brownian motion independent from \( z_3 \). The coefficient \( \kappa \) measures the speed of mean reversion for the process \( y \). Benzoni, Collin-Dufresne, and Goldstein (2007) provide evidence that \( \kappa > 0 \); that is, \( y \) is stationary, so that \( \ell_1 \) and \( \hat{d} \) are co-integrated.

Moreover, consistent with the findings of Carroll and Samwick (1997); Cocco, Gomes, and Maenhout (2005); Gomes and Michaelides (2005); and Gourinchas and Parker (2002), Benzoni, Collin-Dufresne, and Goldstein (2007) assume that the idiosyncratic labor income component is subject to permanent shocks:

\[
d\ell_{2,i}(t) = \left(\alpha(t) - \frac{\nu_2^2}{2}\right) dt + \nu_2 dz_{2,i}(t),
\]

where \( z_{2,i} \) is a standard Brownian motion independent from both \( z_1 \) and \( z_3 \). The subscript \( i \) emphasizes that this shock pertains to the \( i \)-th agent process, in contrast to the aggregate shocks \( z_1 \) and \( z_3 \). Further, the time-dependent drift term \( \alpha(t) \) captures the findings in the literature that the conditional mean of an individual’s labor income is a function of her age. Specifically, when

\[
\alpha(t) = \alpha_0 + \alpha_1 t,
\]

the coefficients \( \alpha_0 \) and \( \alpha_1 \) are calibrated to match the hump shape of earnings over the life cycle (for example, Cocco, Gomes, and Maenhout, 2005).
Taken together, equations 3 and 5–7 yield the following dynamics for the total labor income process \( t = t_i + t_j \):

\[
d(\ell(t)) = \left(-\kappa y(t) + g_d - \frac{\sigma^2}{2} + \alpha(t) - \frac{\nu^2}{2} \right) dt + \nu_1 dz_i(t) + \nu_2 dz_j(t) + (\sigma - \nu_3) dz(t).
\]

Since \( z_i \) and \( z_{i,j} \) are orthogonal to the stock return shock \( z_i \), equations 4 and 9 imply that the contemporaneous correlation between stock market and labor income shocks is

\[
corr(dx, d\ell) = \frac{(\sigma - \nu_3)}{\sqrt{\nu_1^2 + \nu_2^2 + (\sigma - \nu_3)^2}}.
\]

Thus, labor income is contemporaneously uncorrelated with the stock market return when \( \sigma - \nu_3 = 0 \), consistent with empirical evidence. Yet, co-integration generates nonzero long-run correlations between labor income and risky asset returns.

**A comparison with the extant literature**

In previous studies, most authors have specified the labor income process in levels rather than in changes. Furthermore, it is common to write the model in discrete time rather than continuous time. To clarify how the approach in Benzoni, Collin-Dufresne, and Goldstein (2007) relates to the extant literature, here we compare their specifications for the stock price and labor income processes (equations 4 and 9) to those considered in related studies. In particular, we show that in the limit \( \kappa \to 0 \), these specifications are nearly identical to the standard model.

For example, Campbell et al. (2001) assume that the labor income of an investor \( i \) at age \( t \), \( Y_{i,t} \), is exogenously given by

\[
11) \log(Y_{i,t}) = f(t, Z_{i,t}) + \nu_{i,t} + \epsilon_{i,t},
\]

where \( f(t, Z_{i,t}) \) is a deterministic function of age and other individual characteristics \( Z_{i,t} \), \( \epsilon_{i,t} \) is an idiosyncratic temporary shock uncorrelated across households and distributed as \( N(0, \sigma^2_{\epsilon}) \), and \( \nu_{i,t} \) is given by

\[
12) \nu_{i,t} = \nu_{i,-1} + u_{i,t}.
\]

Here, \( u_{i,t} \) is distributed as \( N(0, \sigma^2_{u}) \) and is uncorrelated with \( \epsilon_{i,t} \). Moreover, \( u_{i,t} \) is decomposed into an aggregate component \( \xi_t \) and an idiosyncratic component \( \omega_{i,t} \), uncorrelated across households:

\[
13) u_{i,t} = \xi_{i,t} + \omega_{i,t}.
\]

Further, similar to equation 4, Campbell et al. (2001) assume that the excess return on the risky asset is given by

\[
14) R_{i,t+1} - \bar{R}_t = \mu + \eta_{i,t},
\]

where the innovations \( \eta \) are independent and identically distributed over time and distributed as \( N(0, \sigma^2_{\eta}) \). Campbell et al. (2001) allow for correlation between the aggregate component of labor income shocks, \( \xi_t \), and innovations to stock returns, \( \eta_t \); they denote the correlation coefficient \( \rho_{\xi\eta} \).

Using equation 11 at date \( t \) and date \( (t + \Delta t) \) and then using equation 12, we can write the change in labor income as

\[
15) \log(Y_{i,t+\Delta t}) - \log(Y_{i,t}) = \left[ f(t, Z_{i,t+\Delta t}) - f(t, Z_{i,t}) \right] + [\nu_{i,t+\Delta t} - \nu_{i,t}]
\]

\[
+ \left[ \epsilon_{i,t+\Delta t} - \epsilon_{i,t} \right] + u_{i,t+\Delta t} + \omega_{i,t+\Delta t} + \xi_{t} + \left[ \epsilon_{i,t+\Delta t} - \epsilon_{i,t} \right].
\]

After some relabeling and minor changes, this labor income specification closely matches the specification of Benzoni, Collin-Dufresne, and Goldstein (2007) reproduced in equation 9. Let us ignore for now the temporary shock term \( [\epsilon_{i,t+\Delta t} - \epsilon_{i,t}] \). We do this for two reasons. First, it is not feasible to capture this temporary shock in continuous time in the way that Campbell et al. (2001) do without introducing another state variable, which would significantly increase the difficulty of solving the model numerically. Instead, Benzoni, Collin-Dufresne, and Goldstein (2007) capture the notion of temporary shocks by placing them into the wealth dynamics rather than the labor income dynamics. Second, and more importantly, both Campbell et al. (2001) and Benzoni, Collin-Dufresne, and Goldstein (2007) find this term to have a negligible effect on optimal portfolio decisions. We then relabel \( \Delta t(t) \equiv \log(Y_{i,t+\Delta t}) - \log(Y_{i,t}) \), \( \omega_{i,t+\Delta t} \equiv \nu_2 \Delta z_{2,f}(t) \) and
\[
\left[ f(t, Z_{t+\Delta t}) - f(t, Z_{t}) \right] = \left( g_D - \frac{\sigma_D^2}{2} + \alpha^{(c\infty)}(t) - \frac{\nu_2^2}{2} \right) \Delta t + v_1 \Delta z_1 + v_2 \Delta z_2 + (\sigma - \nu_3) \Delta z_3,
\]

Finally, since Campbell et al. (2001) allow aggregate labor income shocks \( \zeta \) to correlate with innovations in market returns \( \eta \), we decompose \( \zeta \) into two terms \( \xi_\Delta \equiv v_1 \Delta z_1 \) and \( \xi_1 \equiv (\sigma - \nu_3) \Delta z_3 \), which are “orthogonal” and “parallel” to stock market shocks \( \eta \), respectively. Thus, we write \( \zeta \equiv \xi_\Delta + \xi_1 = v_1 \Delta z_1 + (\sigma - \nu_3) \Delta z_3 \). With this relabeling and the dropping of the temporary component term, the labor income dynamics in the Campbell et al. (2001) and Benzonzi, Collin-Dufresne, and Goldstein (2007) models can be written as

\[
\begin{align*}
\Delta \ell^{CCGM} &= \left( g_D - \frac{\sigma_D^2}{2} + \alpha^{(c\infty)}(t) - \frac{\nu_2^2}{2} \right) \Delta t + v_1 \Delta z_1 + v_2 \Delta z_2 + (\sigma - \nu_3) \Delta z_3, \\
\Delta \ell^{BCDG} &= \left( -k v + g_D - \frac{\sigma_D^2}{2} + \alpha^{(c\infty)}(t) - \frac{\nu_2^2}{2} \right) \Delta t + v_1 \Delta z_1 + v_2 \Delta z_2 + (\sigma - \nu_3) \Delta z_3.
\end{align*}
\]

Here, the superscript in \( \alpha^{(t)} \) emphasizes that \( \alpha \) is calibrated for a given \( \kappa \) to match the labor income profile of Cocco, Gomes, and Maenhout (2005). Clearly, the two models differ only in the conditional drift, and are identical in the limit where the mean reversion parameter \( \kappa \to 0 \). Even though these two models are extremely difficult to distinguish econometrically for “small” values of \( \kappa \), Benzonzi, Collin-Dufresne, and Goldstein (2007) show that they have substantially different predictions for the optimal portfolio choice of young agents.

This analysis is also useful to clarify the link with the labor income models considered in recent work by Lynch and Tan (2008) and Storesletten, Telmer, and Yaron (2004, 2007). Storesletten, Telmer, and Yaron (2004) estimate that idiosyncratic risk is strongly countercyclical, with a conditional standard deviation that increases by 75 percent (from 0.12 to 0.21) as the macro-economy moves from peak to trough. In the context of our framework, fluctuations in the \( \nu_j \) coefficients over the business cycle would capture this feature. Storesletten, Telmer, and Yaron (2007) show that when idiosyncratic shocks become more volatile during economic contractions, human capital acquires stock-like features. In a realistic calibration of their model they also obtain a hump-shaped life-cycle investment profile.

Lynch and Tan (2008) extend the work by Storesletten, Telmer, and Yaron (2004, 2007) by showing that the conditional mean of the labor income flow also fluctuates at business cycle frequencies. They use the dividend yield to predict aggregate labor income growth and find that mean labor income growth is procyclical. They refer to this feature as the state-dependent mean channel. Combined with the state-dependent volatility channel of Storesletten, Telmer, and Yaron (2004, 2007), this effect generates realistic portfolio holdings over the life cycle. The Lynch and Tan (2008) state-dependent mean channel is cast within our framework by replacing the state variable that drives the conditional mean of labor income flow in equation 17. In Benzonzi, Collin-Dufresne, and Goldstein (2007), the predictive variable is \( y \), the logarithmic difference between aggregate labor income and dividends, which underlies the co-integration relation. In Lynch and Tan (2008), the predictive variable is the dividend yield. While the condition explored by Lynch and Tan (2008) is weaker than the co-integration relation, it is still sufficiently powerful to have a first-order effect on the agent’s investment decision. Specifically, Lynch and Tan (2008) find the correlation between the growth rate in labor income and the lagged dividend yield to be approximately 3 percent. As they note in their paper, the magnitude may seem small, but the effect on portfolio allocations could be large, much in the same way that return predictability regressions with a low \( R^2 \) coefficient can still induce large hedging demands for stock.

Other previous studies have also considered specifications consistent with the notion that labor income flow and stock returns correlate highly over the long run. For example, Campbell (1996) assumes that labor income follows an autoregressive AR(1) process with low contemporaneous correlation with stock dividends. He finds a highly time-varying discount factor for security prices, and assumes that this same discount factor is appropriate for discounting labor income. This assumption generates a high correlation for stock returns and returns to human capital. Moreover, Santos and Veronesi (2006) consider a model in which labor income and dividends are co-integrated. They show that, consistent with the model’s predictions, the lagged ratio of labor income to consumption predicts stock returns.

Yet not all the literature accords that the long-run correlation of shocks to labor income and stock returns is positive and high. For instance, Lustig and Van Nieuwerburgh (2008) attribute the component of consumption growth innovations that cannot be explained by their model to news about expected future returns on human wealth. They back out the implied human wealth and market return process and conclude that innovations in human wealth and financial asset returns are negatively correlated. This conclusion, however, would
deepen the limited stock market participation puzzle: Under this condition the young agent would want to invest even more in risky assets, since human capital would become a hedge to stock market holdings.

**Nontradable labor income and life-cycle asset allocation**

Benzoni, Collin-Dufresne, and Goldstein (2007) solve the life-cycle portfolio choice problem of an agent who maximizes time-separable constant relative risk aversion (CRRA) utility when the stock return and labor income dynamics are those in equations 4 and 9. They use a 1929–2004 sample of data on total after-tax U.S. employee compensation and dividends on a well-diversified portfolio of U.S. stocks to estimate the coefficients of the co-integration relation in equation 6. Moreover, they calibrate the idiosyncratic labor income dynamics in equation 7 to match the evidence in prior papers that have studied the properties of labor income using household-level data. In their baseline case, they assume an equity premium of 6 percent and a CRRA coefficient of 5. Further, they impose short-selling constraints on the stock and the bond. They do not impose any entry cost to participate in the stock market. Figure 5 illustrates the life-cycle portfolio holdings predicted by this model calibration, and contrasts it to the recommendation of many financial advisers to invest \((100 - \text{age})\%\) of financial assets in stocks. Consistent with empirical evidence, the optimal portfolio share is hump-shaped.

The intuition for this finding is as follows. When the investor is young, there is sufficient time for the co-integration effect to act. Thus, the young agent’s human capital displays a high level of co-movement with the stock market due to long-run labor income risk; that is, human capital has stock-like features. Since much of a young investor’s wealth is tied up in her human capital (financial wealth is relatively small when she is young), she finds herself overexposed to stock market risk and therefore chooses to invest her financial wealth in the risk-free asset. As the investor grows older, co-integration has less time to act so that idiosyncratic shocks become the prevalent source of human capital risk. Since these latter shocks are orthogonal to stock market fluctuations, the investor has an incentive to diversify them away via a larger position in stocks. This effect generates the increasing part of the portfolio holding profile. When the agent approaches retirement, human capital has mainly bond-like features. However, the present value of future labor income flows shrinks to zero, since there are few remaining years of employment. Thus, the agent reduces her position in the stock market to buy more of the risk-free asset.
The hump-shaped life-cycle profile is robust to a wide range of model calibrations. The most important model coefficient is $\kappa$, which measures the time scale of the co-integration relation in equation 6. Larger values of $\kappa$ determine faster reversion of the variable $y$ toward its long-run mean, which tends to increase the long-run correlation between labor income and stock returns. As a result, the worker invests more conservatively; that is, she reduces her stock holdings throughout the life cycle (figure 6). In contrast, when $\kappa$ is smaller the worker invests more aggressively in stocks. When $\kappa$ is zero the effect of long-run labor income risk vanishes (as shown in the previous section). In this case the effect of idiosyncratic shocks prevails, and the worker invests most of her financial assets in stocks. But even for an estimate of $\kappa$ as low as 0.05, which implies a time scale of $\frac{1}{\kappa} = 20$ years, and a risk premium of 4 percent (the same risk premium assumed by, for example, Campbell et al., 2001; Cocco, Gomes, and Maenhout, 2005; and Gomes and Michaelides, 2005), it is optimal for the young agent not to invest in the risky market portfolio (figure 7). This is important, since such a low value of $\kappa$ makes co-integration hardly detectable in the data. Yet, the effect on her risky asset holding is significant.

Increasing the variance of the permanent idiosyncratic shocks increases the diversification motive, inducing an investor to buy more stocks. This effect, however, does not fully offset the long-run aggregate risk component when the investor is young. Consistent with the findings of the prior literature, transient labor income shocks do not have a significant impact on portfolio holdings. Finally, the hump shape of the portfolio profile holds even when we account for stock return predictability. This last result is important, since several recent studies have documented that the expected future stock returns are high when current returns are low. Thus, when returns are predictable an investment in the stock market creates its own hedge, which makes stock ownership even more appealing than when returns are uncorrelated.

In Benzoni, Collin-Dufresne, and Goldstein (2007), the results are quite sensitive to the agent’s attitude toward risk. In their baseline case, they fix the CRRA coefficient at 5, a value well below the upper bound CRRA=10, which most economists find to be reasonable. Of course, higher values of risk aversion reinforce the long-run labor income risk effect and make the agent hold even less of her portfolio in stocks. However, as the agent becomes more risk tolerant, for example, CRRA=3, the diversification motive due to idiosyncratic shocks prevails, and a young investor places most of her financial wealth in stocks (figure 8). This is a nice feature of the model. The literature has
documented a great deal of heterogeneity in stock market participation, and this property is useful to explain the equity premium puzzle (for example, Basak and Cuoco, 1998; and Mankiw and Zeldes, 1991). Heterogeneity in risk aversion (possibly combined with different degrees of exposure to economy-wide and idiosyncratic shocks across agents) is a possible explanation for this evidence.

**The valuation of pension plan obligations, their funding, and the optimal allocation of pension assets**

The ideas set forth in the literature that studies life-cycle asset allocation find direct application in other fundamental problems. For instance, long-run labor income risk strongly affects the valuation of pension plan obligations, their funding, and the allocation of pension assets across different investment classes. In this section, we discuss recent research that has addressed these issues, focusing in particular on the work by Lucas and Zeldes (2006) on defined benefit (DB) pension plans and Geanakoplos and Zeldes (2007) on Social Security.

Lucas and Zeldes (2006) study the valuation and hedging of DB plans. A DB plan awards the employee deferred compensation in the form of future payments (typically a retirement annuity) linked to the length of her tenure with the firm and the salary received during the final year(s) of employment. In spite of much recent growth in defined contribution (DC) plans, a number of firms still offer DB plans as an important part of the retirement package for their employees.

Uncertainty about future wages, the date of the worker’s separation from the firm, and the size and composition of the pool of existing and future employees complicates the analysis of DB plans. These factors affect the measure of the firm’s liability (for example, Lucas and Zeldes, 2006). On one extreme, the firm can focus on a narrow measure of the DB plan’s liabilities that accounts only for accrued benefit obligations (ABOs) toward former and current workers, computed based on current years of employment and wages. On the opposite extreme is a broad measure of the firm’s obligations that also accounts for liabilities toward all employees (former, current, and expected future workers), computed based on past and projected future years of employment and wages. Lucas and Zeldes refer to this latter measure as an “all-inclusive” projected benefit obligation (PBO).

This distinction is important in the analysis of the problem. First, different measures of DB pension liabilities are relevant in various contexts because of institutional restrictions. For instance, the ABO is a legal obligation that the firm can avoid only through bankruptcy. Related, the ABO measure serves as a basis to compute minimum funding requirements by which firms are legally required to abide. Moreover, insurance by the Pension Benefit Guaranty Corporation (PBGC) makes the ABO an essentially safe asset, up to a certain cap. In addition, the valuation and hedging of various measures of DB pension liabilities differ depending on the uncertainty associated with such obligations. For instance, since ABOs are a firm’s obligations of a known amount, they should be discounted accordingly when one computes their present value. Moreover, to fund these obligations the firm should invest the assets in its pension plan entirely in bonds that match the cash flows of the current ABOs (for example, Bodie, 1990, 2006). However, the valuation and funding of PBOs should reflect the risk associated with these uncertain future payments.

The choice of how to optimally fund such obligations is complicated by multiple factors, including taxes, the effect of PBGC guarantees, accounting and tax regulations, corporate liquidity needs (funds tied up in the pension plan may not be easily redirected to other corporate needs), and other labor contracting considerations. Abstracting from some of these issues, Lucas and Zeldes (2006) focus on the problem of hedging PBOs. They argue that, while the hedging of ABOs is best accomplished with a portfolio of bonds, the hedge portfolio for PBOs should contain a mix of stocks and bonds, with a share of stocks versus bonds that depends on firm and worker characteristics—for example, the probability of bankruptcy, worker separation, and mortality. This result is robust to taking into account the possible reduction of future wages by the value of current pension accruals (for example, Bulow, 1982). Moreover, the rate at which to discount uncertain PBOs is a function of similar macromacroeconomic, firm, and worker characteristics.

The intuition for these results is as follows. If wage growth correlates positively with stock returns over the long run, then future pension liabilities will also correlate positively with the performance of the stock market. Thus, stocks should be part of the hedge portfolio, and firms with a higher percentage of active workers should invest more heavily in stocks. Moreover, firms should discount their projected PBOs at a rate that increases with the share of active workers relative to separated and retired employees. Similar to Benston, Collin-Dufresne, and Goldstein (2007), these results are driven by long-run labor income risk: Because of the long-run correlation between labor income flows and stock returns, human capital has a stock-like component, and this component is higher for
younger workers. Thus, the PBO of a firm with a higher fraction of active (that is, younger) workers also has stock-like properties. This feature determines a higher hedge position in stocks, increases the rate at which to discount the PBO, and reduces the PBO's present value.

Lucas and Zeldes (2006) provide evidence consistent, at least in part, with the predictions of their model. Companies with relatively few retirees and separated workers hold more stocks in their pension plans. However, the hedging demand for long-run labor income risk cannot explain why some firms that have a high proportion of retirees and separated workers still invest much of their pension fund assets in stocks.

Similar issues arise when we study the valuation of Social Security obligations. A key input to this problem is the rate at which to discount future liabilities. The traditional actuarial approach uses a risk-free rate to discount future expected cash flows. Geanakoplos and Zeldes (2007) argue that this approach underestimates the riskiness of such obligations. Social Security benefits depend on the realization of the future economy-wide wage level. If future wages and stock market performance correlate positively over the long run, then the appropriate discount rate for Social Security obligations toward active workers should exceed the risk-free rate. This risk adjustment reduces the present value of the obligation, which is relevant to assessing the projected burden of Social Security on the taxpayer. Moreover, there is much debate on the costs and benefits associated with investing a fraction of the Social Security fund in stocks (for example, Abel, 2001). This problem resembles optimal allocation of the assets that fund private DB pension plans. Thus, the results derived in Lucas and Zeldes (2006) apply to this setting, too. Specifically, the portfolio that hedges projected Social Security obligations contains a share of stocks that depends on macroeconomic conditions and worker characteristics.

Finally, there is a heated debate in the U.S. about the opportunity to replace part of the existing DB Social Security system with a system of DC personal accounts. If such a reform were to occur, it is possible that the private sector would take over some of the obligations that are currently guaranteed by Social Security. For instance, Geanakoplos and Zeldes (2008) advocate a system of progressive personal accounts with two main features. First, accruals in the personal accounts would be in a new kind of derivative security that pays its holder one inflation-adjusted dollar during every year of life after her statutory retirement date, multiplied by the economy-wide average wage at retirement date. They call this derivative a personal annuitized average wage security (PAAW). Second, households would buy their new PAAWs each year with their Social Security contributions, augmented or reduced by a government match. Some of these securities, which effectively define benefits for the future retiree, could be pooled together and sold to financial markets. In this event, how would investors price them? Geanakoplos and Zeldes (2007) show that accounting for long-run labor income risk is a key ingredient in a model to value these claims.

Conclusion

The recent literature has offered various alternative explanations for the limited stock market participation puzzle. The discussion here, focused on the work of Benzoni, Collin-Dufresne, and Goldstein (2007), shows that long-run labor income risk has a first-order effect on optimal life-cycle asset allocation. We make no attempt to discuss the other numerous important contributions, which are reviewed in the excellent articles by, for example, Campbell (2006) and Curcuru et al. (2004). We do not view the explanation discussed here as a substitute for these previous theories, but rather as a complement.

The importance of long-run labor income risk is further underscored in the recent work by, for example, Lucas and Zeldes (2006) and Geanakoplos and Zeldes (2007, 2008). In particular, these studies show that long-run labor income risk is an important conduit through which macroeconomic uncertainty affects the valuation of DB pension plans, their funding, and the allocation of pension assets across different investment classes.

The ideas developed in Benzoni, Collin-Dufresne, and Goldstein (2007) are also potentially useful to shed light on other important topics. For instance, heterogeneity in risk aversion combined with different degrees of exposure to long-run labor income risk can generate limited stock market participation. Thus, an extended version of the model with two different agent groups that endogenously choose whether to buy stocks may provide a general equilibrium foundation for the setting considered by, for example, Basak and Cuoco (1998) and Mankiw and Zeldes (1991), who show that limited stock market participation helps explain the equity premium puzzle.

Finally, it is natural to conjecture that, similar to labor income, real estate ownership is an important conduit for macroeconomic uncertainty. For instance, Quan and Titman (1997) argue that the housing and stock markets are co-integrated. Since real estate has a significant share in the portfolio of most households, a model that accounts for the long-run correlation between real estate and stock market returns would prescribe that an investor should be even more cautious about bearing stock market risk.
We use data from the 1998, 2001, 2004, and 2007 Surveys of Consumer Finances to construct the plots in figures 1–4 (pp. 4–7). The SCF is an interview survey of U.S. households sponsored by the Board of Governors of the Federal Reserve System. The survey contains information on household balance sheets, income, labor force participation, and demographic characteristics. It has been conducted every three years since 1983; the most recent available data were collected in 2007, when 4,422 households were interviewed.

We downloaded the SCF data from the SCF website at www.federalreserve.gov/pubs/oss/oss2/scfindex.html, and we produce core variables using the SCF macro posted at www.federalreserve.gov/pubs/oss/oss2/bulletin.macro.txt. In our analysis, we mainly focus on four variables produced by the macro: the age of the head of the household (denoted by \( \text{AGE} \) in the macro), financial assets \( (\text{FIN}) \), financial assets invested in stocks \( (\text{EQUITY}) \), and sample weights \( (\text{WGT}) \).

We use the \( \text{AGE} \) variable to create a new categorical variable that splits the population into seven age groups: 18–25, 26–30, 31–40, 41–50, 51–60, 61–65, and 66 and above. In figures 1–4, the horizontal axis values of the points that make up the plots are the midpoints of these age intervals. Financial assets \( (\text{FIN}) \) include checking, savings, money market, and call accounts; certificates of deposit; mutual funds; stocks; bonds; IRAs; cash value of life insurance; business assets; and other managed assets. Financial assets invested in stocks \( (\text{EQUITY}) \) include directly held stocks, stock mutual funds, IRAs/Keoghs invested in stock, other managed assets with equity interest (annuities, trusts, and managed investment accounts), and thrift type retirement accounts invested in stock. The SCF’s sample design consists of two parts: a standard geographically based random sample and a special oversample of relatively wealthy families. Thus, we use the weights \( (\text{WGT}) \) provided in the survey to combine information from the two samples and make estimates for the full population.

To create the subsample of stockholders we use the variable \( \text{HEQUITY} \), which equals one if \( \text{EQUITY} \) is greater than zero. The percentage of households holding stocks is given by the mean of the \( \text{HEQUITY} \) variable. Our measure of the share of stocks in the portfolio of financial assets is the ratio of the variables \( \text{EQUITY} \) and \( \text{FIN} \) when \( \text{FIN} \) is strictly positive, and is zero when \( \text{FIN} \) is zero.

1For instance, it is impossible to separately identify three effects on life-cycle asset allocation: the investor’s age, the investor’s birth cohort, and the time of observation (Ameriks and Zeldes, 2004). This is because the investor’s age is given by the difference between the date at the time of observation and her birth date. As a result, researchers typically focus on two of the three effects and set the third one (typically the cohort effect) to zero.

2Geanakoplos and Zeldes (2008) advocate a system of regulations to ensure that firms purchasing these securities fully collateralize their obligations. While Social Security obligations are guaranteed by the federal government, a privatized system would not have such a guarantee.
REFERENCES


Preannounced tax cuts and their potential influence on the 2001 recession

R. Andrew Butters and Marcelo Veracierto

Introduction and summary

The 2001 recession differed from previous recessions in several ways. First, it was quite mild in terms of its associated contractions in output and consumption. Also, since total hours worked fell sharply, labor productivity remained relatively high. Furthermore, while business fixed investment plummeted (actually, much more than in a typical recession), residential investment and purchases of durable goods remained surprisingly strong. This is highly unusual: Typically, residential investment and purchases of durable goods collapse during recessions, often leading the general contraction in economic activity by several quarters.

Another distinctive feature of the 2001 recession was that it was preceded by a presidential election dominated by tax cut discussions. The proposals of the two major candidates differed in crucial ways. While the Democratic candidate, Al Gore, promised cuts that would leave statutory income tax rates essentially unchanged (most cuts would come in the form of tax credits for particular economic activities), the Republican candidate, George W. Bush, announced a plan that would significantly reduce income tax rates across all income brackets. Thus, the outcome of the 2000 presidential election promised to have a large impact on the tax rates that households and businesses would face in the future.

A basic hypothesis in this article is that the two sets of facts—the unusual features of the 2001 recession and the tax cuts promised during the 2000 presidential election—could be related. The rationale for this view is that people and firms are forward-looking: Expectations about the future may have a significant effect on the decisions that they make today. For instance, the anticipation of higher demand may lead a producer to expand his production capacity, or the anticipation of higher wages in a particular occupation may induce a worker to acquire specific skills. Anticipated tax cuts are no exception. If tax rates are expected to decrease in one year, the current year becomes a relatively bad year for working and investing. Forward-looking households and businesses may thus decide to devote less time to market activities, cutting back on time worked in the market and increasing time worked at home and substituting business investment for home investment. These contractionary effects of anticipated tax cuts could have played an important role in the patterns of activity observed during the 2001 recession.

Of course, the anticipated tax cuts were not the only factor potentially influencing economic activity during the 2001 recession. A number of other important shocks and policy responses also occurred in 2000 and 2001. For starters, market participants apparently began to reevaluate the profitability of many investment projects in the high-tech sector. This and other factors were reflected in a sharp decline in equity prices starting the spring of 2000. In addition, in 2001 there were the terrorist attacks on September 11, followed by the revelation of the Enron scandal later that fall. Moreover, the Federal Reserve lowered its policy rate substantially over the course of 2001, which influenced costs underlying household and business decisions regarding the purchase of durables and capital goods.

In order to determine the possible effects of anticipated tax cuts, we construct and analyze a theoretical model that abstracts from these other influences on the economy. The model will thus tell us if the anticipated tax effects can plausibly reproduce some of the patterns observed in the data. However, it is important to point out that since the other factors are excluded, we cannot use...
the analysis to rank the relative importance of taxes and these other influences on the economy over this period.

The model we use is a version of the Greenwood and Hercowitz (1991) home production model. In this model, the economy is populated by a representative household that values consumption of a market good and consumption of a home good. The home good is produced using home capital and time spent at home. The market good is produced using business capital and time worked in the market. Output of the market good can be consumed, invested in business capital, invested in home capital, or consumed by the government. The government finances its expenditures by taxing capital and labor income. Moreover, the government is assumed to balance its budget every period. Admittedly, the model is quite simple. However, it captures important decision margins, and therefore, we consider it a useful starting point for the analysis.

Selecting model parameters to reproduce salient features of the U.S. economy, we find that, while immediate tax cuts generate a boom in economic activity, delayed tax cuts initially generate a recession. Our analysis underscores the importance of taking forward-looking behavior on the part of households and businesses into account in considering the impact of policy alternatives. In particular, taking this behavior into account can help us understand some of the patterns in activity observed during the 2001 recession.

There are a number of papers that have previously analyzed the effects of anticipated changes to the economic environment (for example, Jaimovich and Rebelo, 2008, 2009; and Beaudry and Portier, 2007). However, the most closely related is the one by House and Shapiro (2006). Their paper also evaluates the effects of the 2001 tax reform. However, they focus on the effects of phased-in tax cuts from the time that the reform was signed into law, and they consider a model in which business capital is the only form of capital. Contrary to House and Shapiro (2006), we emphasize the anticipatory effects of the reform before it was signed into law, and introduce home capital into the analysis. Both extensions allow us to analyze the start of the 2001 recession and evaluate whether the model is able to generate the unusual strength in home investment that was observed during that recession.

In the next section, we present the salient observations from the 2001 recession. Then, we describe the tax reforms that were promised during the 2000 presidential campaigns, as well as the tax reform that was actually implemented. Next, we explain the model economy. We describe the competitive equilibrium to be analyzed and how the model’s parameters are selected. Finally, we present our results.

The 2001 recession

On November 26, 2001, the National Bureau of Economic Research (NBER) issued a statement announcing that the U.S. economy had reached a peak in business activity in March 2001 and had moved into a recessionary period. The NBER report cited falling industrial production as the most significant piece of evidence to suggest the economy had slowed. Poor real sales and employment also provided evidence supporting the decision to announce a recession. While employment peaked in March, in parallel with the NBER peak date, both industrial production and sales had peaked six and seven months before that date, respectively. The NBER committee mentioned in its statement that earlier dates had been considered to reflect the “divergent paths” of manufacturing and employment, but these dates were dismissed because of the lower emphasis placed on the manufacturing and goods-producing sectors of the economy.

On July 17, 2003, the NBER reported that the economy had reached a trough in November of 2001, ending the recession. The strength of both real gross domestic product (GDP) and real personal income relative to levels before the recession allowed the NBER committee to conclude that any future downturn in the economy would in fact be a separate recession and not a continuation of the 2001 recession. Nevertheless, industrial production and employment showed no sign of recovery.

To gain a more detailed understanding of the 2001 recession, figure 1 reports the paths of output, consumption, hours worked, business investment, and home investment leading up to and during the 2001 recession. For comparison, it also reports the average of those paths before and during the previous six recessions. For consistency with the model used later on, residential investment and personal consumption expenditures on durables goods are combined into a single measure denoted home investment. In turn, business investment is defined as private nonresidential fixed investment plus changes in inventories, and consumption is restricted to consumption of nondurables and services. Because our model economy will be closed, output is defined as GDP minus net exports (that is, gross domestic purchases). All of these variables are reported in real terms. For hours worked, we focus on a broad measure constructed by Prescott, Ueberfeldt, and Cociuba (2009), which includes military personnel. Because our model will have no growth component, we detrend each series using a deterministic trend.

A quick glance at figure 1 indicates that, relative to the standard recession, the 2001 recession was highly atypical in several respects. Output and consumption (panels A and B) fell during 2001, but not as much as
Notes: All variables are normalized (indexed) to 100 at the recession peaks. Time 0 indicates the recession peak quarter. The average recession is based on those that occurred in 1960–61, 1969–70, 1973–75, 1980, 1981–82, and 1990–91, according to the National Bureau of Economic Research.

Source: Authors’ calculations based on data from the U.S. Bureau of Economic Analysis, National Income and Product Accounts of the United States, from Haver Analytics.
in the average recession. Once the 2001 recession started, hours worked (panel C) behaved similarly to the average recession. However, during the three quarters leading up to the 2001 recession, there was a steady decline in hours worked compared with the constant levels leading up to the average recession. For the 2001 recession, the decline in business investment (panel D) was much sharper and started much earlier. Perhaps most notably, the 2001 downturn had minimal effects on home investment (panel E). On average, home investment’s decline leads an upcoming recession, while there were no noticeable effects both before and during the 2001 recession.

Later on, we will show that the anticipation of future tax cuts could have contributed to some of these atypical features of the 2001 recession (for example, the relatively strong consumption and home investment). In order to do this, we must first identify reasonable estimates for two critical elements of the analysis: 1) when economic agents began anticipating the future tax cuts and 2) what was the particular tax cut schedule that economic agents were anticipating. We will examine the 2000 presidential campaigns and election, as well as the implementation of the Economic Growth and Tax Relief Reconciliation Act of 2001 (EGTRRA), to determine these two elements.

The presidential campaigns and the 2000 election

On March 14, 2000, both George W. Bush and Al Gore won their respective party’s nomination to become the 43rd President of the United States. Over the next eight months, both candidates campaigned and presented the American public with their own proposals to stimulate the economy.9

The Republican candidate, George W. Bush, ran on a platform with across-the-board marginal rate tax cuts as one of its foundations. Leading up to the election, the total cost of the cuts was estimated at $1.3 trillion over the nine-year period 2002–10. In the plan, the 28 percent and 31 percent tax brackets would both be dropped to 25 percent. The 15 percent bracket would be dropped to 10 percent, and both the 36 percent and the 39.6 percent tax brackets would be reduced to 33 percent.10 All of these cuts were proposed to be “phased in” starting in 2002, with a further reduction in 2004, and with all of the effects being implemented by 2006.

Al Gore, the Democratic candidate and incumbent Vice President, proposed a tax plan more conservative in cost (estimated at $500 billion) and more geared to the low- and middle-income classes. His tax reform included raising the standard deduction, with tax breaks and deductions for savings accounts, child care, college tuition, and long-term caregivers. A tax credit for new retirement savings accounts was the most substantial of these proposals.

Although both candidates promised significant tax cuts, their proposals differed in a fundamental way. While the Republican candidate promised reductions in marginal tax rates, the Democratic candidate promised cuts in inframarginal taxes. This is an important distinction, since reductions in marginal tax rates tend to increase labor supply, while reductions in lump-sum taxes have the opposite effect. These differences made it difficult for economic agents to adjust their behavior to the prospective tax cuts. The reason is that adjusting to one type of reform would have produced large errors had the alternative reform been implemented.

It would be extremely difficult to determine at each point in time the economic agents’ beliefs about the likelihood of either type of reform being implemented and, therefore, the future taxes they were anticipating. However, it is convenient for the purposes of this article to make a number of not entirely implausible assumptions. First, since the election was so tight and the Florida recount actually postponed its outcome for almost a month after election day (November 7), it seems reasonable to assume that until the end of 2000, economic agents were putting a 50/50 chance on either type of reform being eventually implemented. Second, since adjusting to each type of reform required such drastically different types of labor supply responses, it is not implausible to assume that agents waited until the election outcome before making any changes to their behavior. Third, we assume that, once George W. Bush was declared the new President of the United States, economic agents immediately shifted their expectations about future tax cuts to what had been promised during his campaign. Fourth, we assume that once a slightly different reform was later implemented, economic agents adjusted their expectations accordingly. In the next section, we describe the reform that was actually implemented.

The implementation of the 2001 tax cuts

The Economic Growth and Tax Relief Reconciliation Act was signed into law by George W. Bush on June 7, 2001. As proposed in Bush’s campaign for the presidency, the law’s most substantial changes involved an across-the-board reduction in the marginal tax rates. A 0.5 percentage point cut in the marginal rates for all tax brackets above the 15 percent rate became effective immediately. The law stipulated subsequent cuts in 2002, 2004, and 2006 of 0.5 percentage points, 1 percentage point, and 1 percentage point, respectively, for each tax bracket (the only exception being a cut of 2.6 percentage points for the highest bracket in 2006). This schedule
would remain in effect until 2011, when the tax rates would revert, or “sunset,” to their pre-EGTRRA rates. In addition, the law phased out the estate tax and sent a tax rebate check of $300 to each individual. An increase in the child credit from $500 to $1,000 and relief from the alternative minimum tax (AMT) and the marriage penalty rounded out the bill. Although the rebate checks were highly visible in 2001, they did very little to affect marginal tax rates (House and Shapiro, 2006).

Relative to the tax cuts that George W. Bush had proposed during his campaign, EGTRRA differed in several ways. First, the initial cuts to marginal rates of EGTRRA became effective immediately (in June 2001) and were retroactive to the beginning of the year. In proposals during the campaign, the Bush tax cuts were not to take place until 2002. Next, as seen in table 1, the ultimate percentage cuts for some tax brackets signed into law were slightly smaller than what had been proposed to Congress. For the 31 percent and 39.6 percent tax brackets (panel A), proposed cuts of 6 percentage points and 6.6 percentage points, respectively (panel B), were scaled back to 3 percentage points and 4.6 percentage points (panel C). In addition, an explicit “sunset” date of January 2011 was put on all marginal tax rate changes (Brumbaugh et al., 2002).

A study administered by the Congressional Budget Office (2001, p. 34, boxes 2–3), or CBO, estimated the effective marginal tax rates (for both labor and capital income) before and after EGTRRA. Effective marginal tax rates depend on other features of tax law beyond the statutory rate, including the earned income tax credit, the child tax credit, and the AMT, among others. The analysis by the CBO attempted to take these other provisions into account when determining the estimated change due to EGTRRA.

The CBO’s estimates of effective marginal tax rates of labor and capital income are reported in table 1 (the last two columns of data). We see that, according to the CBO, the effective marginal tax rate on labor fell from a pre-EGTRRA level of 36.20 percent (panel A) to 34.40 percent (fourth row of panel C) and that the effective marginal tax rate on capital fell from 37.43 percent to 36.41 percent, once EGTRRA was fully phased in (in 2006). A more formal discussion on the taxation of capital can be found in the appendix.

### Table 1

<table>
<thead>
<tr>
<th>Date</th>
<th>Labor tax rate ((\tau))</th>
<th>Capital tax rate ((\tau))</th>
</tr>
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<tbody>
<tr>
<td><strong>A. Pre-EGTRRA</strong></td>
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<tr>
<td>Before 2001:Q1</td>
<td>28</td>
<td>31</td>
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<tr>
<td></td>
<td>36</td>
<td>39.6</td>
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<td></td>
<td>36.20</td>
<td>37.43</td>
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<td><strong>B. Campaign proposal</strong></td>
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<td>36</td>
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<td></td>
<td>34.58</td>
<td>36.52</td>
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<tr>
<td>2006:Q1 and beyond</td>
<td>25</td>
<td>25</td>
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<td>33</td>
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<td></td>
<td>33.77</td>
<td>36.07</td>
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<td><strong>C. EGTRRA</strong></td>
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<tr>
<td>2001:Q3–2001:Q4</td>
<td>27.5</td>
<td>30.5</td>
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<tr>
<td></td>
<td>35.5</td>
<td>39.1</td>
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<td>2004:Q1–2005:Q4</td>
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<td>2011:Q1 and beyond</td>
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<td></td>
<td>36</td>
<td>39.6</td>
</tr>
<tr>
<td></td>
<td>36.20</td>
<td>37.43</td>
</tr>
<tr>
<td>2011:Q1 and beyond</td>
<td>28</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>39.6</td>
</tr>
<tr>
<td></td>
<td>36.20</td>
<td>37.43</td>
</tr>
</tbody>
</table>

Notes: EGTRRA means the Economic Growth and Tax Relief Reconciliation Act of 2001. This table shows the tax rates for the brackets above the 15 percent rate. The schedule for the effective marginal tax rates on both labor and capital is taken from House and Shapiro (2006). By using the same weighting procedure used by House and Shapiro (2006), we interpolate the effective marginal tax rates if George W. Bush’s proposed tax schedule (panel B) had been enacted.

Sources: Authors’ calculations based on data from House and Shapiro (2006) and Congressional Budget Office (2001).
tax rates that were proposed by George W. Bush during the presidential campaign. These tax rates are reported in the last two columns of panel B. The effective marginal tax rates in panels B and C are the ones that will be used to determine economic agents’ expectations at each point in time. In particular, we will assume that starting in 2001:Q1 agents were anticipating the effective marginal tax rates provided in panel B, but that in 2001:Q3 (that is, after the passage of EGTRRA) they switched their expectations to the effective marginal tax rates listed in panel C. These expectations will play an important role in the model economy to be described next.

The model

The model economy consists of three sectors: a household sector, a firms sector, and a government sector. The household sector is composed of a large number of identical individuals that supply labor and business capital to the firms. In addition, they produce a home good, using time and home capital. The firms sector is composed of a large number of identical firms that produce the market good, using business capital and labor. The government needs to purchase a certain amount of the market good every period. These expenditures are financed with a combination of capital income, labor income, and lump-sum taxes. In what follows we describe the model in detail.

The household sector

The representative household has preferences described by the following utility function:

\[ U = \sum_{t=0}^{\infty} \beta^t [\psi \ln c_t + (1 - \psi) \ln h_t], \]

where \( c_t \) is consumption of a market-produced good, \( h_t \) is consumption of a home-produced good, \( 0 < \beta < 1 \) is the subjective time discount factor, and \( 0 < \psi < 1 \). The representative household is endowed with one unit of time.

At the beginning of period \( t \), the household owns \( k_t \) units of business capital and \( d_t \) units of home capital. Both types of capital can be accumulated using a standard linear technology. In particular,

1) \[ k_{t+1} = (1 - \delta^k) k_t + i^k_t, \]

and

2) \[ d_{t+1} = (1 - \delta^d) d_t + i^d_t, \]

where \( i^k_t \) is gross business investment, \( i^d_t \) is gross home investment, \( 0 < \delta^k < 1 \) is the depreciation rate of business capital, and \( 0 < \delta^d < 1 \) is the depreciation rate of home capital. At the beginning of date \( 0 \), the stock of business capital \( k_0 \) and the stock of home capital \( d_0 \) are given.

The home good is produced according to the following production function:

3) \[ y_t = K_t^\alpha L_t^{1-\alpha}, \]

where \( L_t \) is the amount of labor, \( K_t \) is the stock of business capital, and \( L_t \) is the amount of labor. Observe that since the time endowment is equal to one, \( 1 - n_t \) is the amount of time that the household spends in home activities.

The household’s budget constraint is given as follows:

4) \[ c_t + i^k_t + i^d_t + T_t \leq \{1 - \tau^k_t\} w_t n_t + \{1 - \tau^d_t\} r_t k_t + \tau^d_t \delta^d k_t, \]

where \( w_t \) is the wage rate, \( r_t \) is the rental rate on capital, \( \tau^k_t \) is the tax rate on labor income, \( \tau^d_t \) is the tax rate on capital income, and \( T_t \) is the lump-sum tax. Observe that the household receives a tax depreciation allowance given by \( \tau^d_t \delta^d k_t \). Also observe that the household uses its after-tax labor and capital income to consume, to invest in business capital, to invest in home capital, and to pay lump-sum taxes. The household takes the lump-sum taxes \( T_t \), the tax rates \( \tau^k_t \) and \( \tau^d_t \), and the prices \( w_t \) and \( r_t \) as given.

The household’s problem is to maximize the utility function (equation 1) subject to equations 4 and 5.

The firms sector

The representative firm produces the market good using the following production function:

5) \[ y_t = K_t^\alpha L_t^{1-\alpha}, \]

where \( L_t \) is labor, \( K_t \) is business capital, and \( 0 < \theta < 1 \).

The firm solves the following static profit maximization problem:

6) \[ \max \{y_t - r_t K_t - w_t N_t\}, \]

subject to equation 6. That is, the firm maximizes the difference between the revenues that it receives from selling its output and the total rental payments on capital and labor. The firm takes the rental rate of capital \( r_t \) and the wage rate \( w_t \) as given.
**The government sector**

The government needs to make a sequence of expenditures \( g_{i, t} \). These expenditures are exogenous—that is, they are determined outside the model. However, the following government budget constraint must be satisfied:

\[
g_{i, t} = \tau_{i}^{c} w_{i, t} n_{i, t} + \tau_{i}^{b} r_{i, t} k_{i, t} - \tau_{i}^{k} \delta_{i, t} k_{i, t} + T_{i, t}.
\]

That is, government expenditures must be financed with tax revenues.\(^{17}\)

**Market clearing**

At equilibrium all markets must clear. In particular,\(^{8}\)

\[
c_{i, t} + i_{i, t}^{d} + i_{i, t}^{k} + g_{i, t} = y_{i, t}.
\]

That is, consumption of the market good \( c_{i} \) plus total investment \( i_{i}^{d} + i_{i}^{k} \) plus government expenditures \( g_{i} \) must be equal to output \( y_{i} \).

Also,

\[
K_{i, t} = k_{i, t},
\]

and

\[
N_{i, t} = n_{i, t}.
\]

That is, the rental markets for capital and labor must clear.\(^{18}\)

**Selection of parameter values**

With constant government expenditures and tax rates, the model economy eventually settles into a steady state where consumption, business capital, home capital, output, hours worked, and all prices are constant over time. In what follows, model parameters are chosen so that this steady state reproduces key observations about the U.S. economy. Since there are nine parameters to choose, we target nine observations. The parameters to be selected are \( \beta, \psi, \alpha, \theta, \delta_{d}, \delta_{k}, g, \tau^{c}, \) and \( \tau^{k} \).

Before proceeding we need to identify empirical counterparts for the different types of capital. In what follows we identify the stock of home capital \( d \) with the sum of residential structures and consumer durable goods. As a consequence, we associate home investment \( i^{d} \) with gross private residential fixed investment plus personal consumption expenditures on durable goods (from the U.S. Bureau of Economic Analysis’s national income and product accounts, or NIPAs). In turn, we identify the stock of business capital \( k \) with total fixed assets minus residential structures. That is, \( k \) includes private business structures, equipment, and software, as well as all forms of government capital. As a consequence, we associate business investment \( i^{k} \) with private nonresidential fixed investment plus government gross investment (from the NIPAs).

Using annual data from 1967 through 2007 published in the NIPAs, we find that the corresponding average annual investment rates \( i^{d}/d \) and \( i^{k}/k \) are equal to 9.1 percent and 8.5 percent, respectively, and that the average investment–output ratios \( i^{d}/y \) and \( i^{k}/y \) are equal to 14.9 percent and 12.7 percent, respectively.\(^{19}\) This provides four target observations.

Two additional target observations are the share of labor in national income (equal to 70 percent) and the average fraction of time spent working by the total civilian noninstitutional population aged 16–64 and military personnel (equal to 27 percent).\(^{20}\) The first observation, which is standard in the macroeconomics literature, is obtained from the NIPAs. The second observation, which corresponds to the period 1967–2007, is from Prescott, Ueberfeldt, and Cocciuba (2009).

The last three observations that we use are associated with the government sector. The first of these observations is a government expenditures ratio \( g/y \) equal to 16 percent, which is the average over the period 1967–2007 in the NIPAs. The other two observations are the pre-EGTRRA effective marginal tax rates on labor and capital that were described in table 1 (p. 21).

Table 2 lists the parameter values that generate these nine observations when the model’s time period is set to one quarter.

**Results**

In this section, we analyze the effects of introducing different types of tax reforms to the economy calibrated in the previous section. The purpose of the exercises is twofold: to compare the effects of anticipated tax cuts with those of unanticipated tax cuts and to explore whether anticipated tax cuts may have contributed to generating some of the atypical features of the 2001 recession. In all cases we will assume that in 2000:Q4, the economy was at the steady state calibrated in the previous section.

**The effects of immediate tax cuts**

The first experiment is to evaluate the effects of immediate tax cuts—that is, a tax cut reform that introduces no delays between the time of its announcement and the time of its implementation. The experiment’s purpose is to illustrate how the model works and to facilitate comparisons with a delayed reform later on. The particular tax cuts considered are the total tax cuts promised by George W. Bush during the presidential campaign. In particular, we assume that in 2001:Q1 economic agents learn that their marginal tax rate on capital \( (\tau^{k}) \) is immediately and permanently reduced from its pre-EGTRRA rate of 37.43 percent to 36.07 percent. Similarly, we assume that
the marginal tax rate on labor ($\tau^l$) is immediately and permanently reduced from 36.2 percent to 33.77 percent (see first and last rows of panel B in table 1, p. 21). We want to emphasize that this exercise is purely illustrative: As was described previously, George W. Bush did not promise that these tax cuts would take place immediately but that they would be phased in over a period of several years.

Figure 2 shows the evolution of the economy after this reform. We see that, in the model, the reform generates a boom in economic activity. The lower income tax rates increase the returns to working in the market and to investing in business capital. As a consequence, hours worked (panel C) and business investment (panel E) increase during the first period of the reform. Also, the lower reliance on distortionary taxes makes households feel richer, and they respond by increasing their consumption (panel B). Observe that during the first period of the reform there is a sharp drop in home investment (panel F). The reason is that the lower tax rate on business capital changes the desired mix of capital. In particular, households want to hold more business capital and less home capital.

During the second period of the reform, business investment drops and home investment increases. The reason is that the correct capital mix is achieved during the first period of the reform, both types of capital start growing at a more balanced pace. As business capital increases during the subsequent periods, output (panel D) and consumption continue to grow and hours worked start to decrease.

The effects of delayed tax cuts

In the previous section, we considered a scenario in which the total tax cuts promised by George W. Bush during his presidential campaign were immediately implemented. The scenario was highly unrealistic: In actuality, his promise was to gradually reduce tax rates in 2002, 2004, and 2006, with the total tax cuts taking full effect only by 2006. Here we consider the scenario in which not only the total tax cuts but their pace of reduction are the ones promised during the campaign. In particular, the sequence of tax rates $\tau^b_t$ and $\tau^l_t$ introduced are those given by the last two columns of panel B in table 1 (p. 21). The purpose of this experiment is twofold: First, it illustrates the effects of preannouncing tax cuts instead of implementing them as surprises; second, it evaluates the effects that might have been obtained had the tax reform promised by George W. Bush during his campaign been implemented.

Figure 3 shows the evolution of the economy starting in 2001:Q1, when economic agents first learn that tax rates will be reduced in the future. We see that in the model economy the delayed reform generates a recession during 2001. The reason is that the anticipated tax reduction makes 2001 a relatively bad year for working and investing. Economic agents essentially take a break from market activities, substituting time worked in the market for time worked at home and substituting business investment for home investment. Most of the investment adjustment takes place in 2001:Q1, when there is a sharp decline in business investment (panel E) and a sharp increase in home investment (panel F). Also observe that consumption (panel B) immediately jumps to a permanently higher level because the lower future tax rates make the representative household richer. Later, in 2001:Q4, agents know that taxes are going to be cut the following quarter, so they prepare for this by increasing business investment and decreasing home investment. This leaves agents at the start of 2002:Q1 with a higher stock of business capital and a lower stock of home capital, which are appropriate for the sharp substitution in time worked at home for time worked in the market (panel C) and for the increase in output (panel D) that subsequently takes place.

The effects of EGTRRA

The “delayed tax reform” scenario of the previous section seems to be a plausible description of how prospective tax cuts may have affected the economy through 2001:Q2. There are two reasons for this. First, although George W. Bush was already announcing his intentions of cutting marginal tax rates during his 2000 presidential campaign, it seems unlikely that this may have had significant effects on economic decisions before 2001:Q1. If economic agents had changed their behavior in anticipation of George W. Bush winning the election (and marginal tax rates being reduced), they would have regretted it later on had Al Gore become the new president (and marginal tax rates had remained unchanged). Given the high uncertainty about the election outcome and given

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**TABLE 2**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>0.9868</td>
</tr>
<tr>
<td>$\psi$</td>
<td>0.286</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.143</td>
</tr>
<tr>
<td>$\theta$</td>
<td>0.30</td>
</tr>
<tr>
<td>$\delta^b$</td>
<td>0.02274</td>
</tr>
<tr>
<td>$\delta^l$</td>
<td>0.02112</td>
</tr>
<tr>
<td>$g^*$</td>
<td>$0.16 \times y$</td>
</tr>
<tr>
<td>$\tau^b$</td>
<td>0.362</td>
</tr>
<tr>
<td>$\tau^l$</td>
<td>0.3743</td>
</tr>
</tbody>
</table>

Note: The government-expenditures-to-output ratio ($g/y$) is equal to 0.16.
the risk of erring in either direction, it seems reasonable to assume (as a first approximation) that economic agents waited until the election outcome before changing their behavior. Second, it seems plausible to think that once forward-looking economic agents learned by the end of 2000:Q4 that George W. Bush would become the new president, they started to adjust their behavior in anticipation of the tax cuts announced during his presidential campaign.

While being a plausible description of the effects of prospective tax cuts through 2001:Q2, the “delayed tax reform” scenario of the previous section does not apply...
after 2001:Q2. The reason is that the actual tax reform passed by Congress and signed into law in June 2001, EGTRRA, differed in significant ways from the tax reform that George W. Bush had announced during the campaign: 1) The total tax cuts were smaller (although they would still take full effect by 2006), 2) a “sunset” provision was incorporated, and 3) small tax cuts were already given for the year 2001 (retroactively to the beginning of the year). So, in a third scenario that follows, we will assume that economic agents are surprised by the actual passage of EGTRRA and that they revise their expectations accordingly. In particular, we will assume
that in 2001:Q3 economic agents start to believe that the future sequence of tax rates $\tau^i_t$ and $\tau^t_t$ will be given by the last two columns of panel C in table 1 (p. 21).

Figure 4 shows the complete evolution of the economy. By construction, the path that the economy follows through 2001:Q2 is identical to that of the “delayed tax reform” scenario. However, starting in 2001:Q3, the path is significantly different. Since now households find out that some tax cuts already take place in 2001, they immediately shift hours worked at home to hours worked in the market (panel C) and increase the amount of output produced (panel D). Because of the substitution toward market activities, we also see that in 2001:Q3 there is an increase in business investment (panel E) and a drop in home investment (panel F). Consumption (panel B) drops, however, because agents learn that they are not as rich as they initially believed: EGTRRA now incorporates a “sunset” provision. In anticipation of further tax cuts that will take place in 2002:Q1, business investment remains relatively high in 2001:Q4 and home investment remains relatively low. Once the tax rates are reduced in 2002:Q1, there is an additional increase in hours worked and output, while business investment and home investment stabilize around their pre-EGTRRA levels.

**Adjustment costs**

We saw in the previous section that in the model economy, the expectations of future tax cuts during the early part of 2001, followed by the actual implementation of EGTRRA, generate a short-lived recession during 2001 in which hours worked and output fall, while consumption remains relatively strong. These are features observed in the actual 2001 recession (see figure 1, p. 19). However, home investment is extremely strong during the early part of the year and extremely weak during the second half of the year (panel F in figure 4). The opposite is true with business investment (panel E in figure 4). These large swings in investment are highly counterfactual (see figure 1, p. 19).

In order to improve the performance, we introduce adjustment costs to the model economy. In particular, we assume that it is costly to change both types of investments from their levels in the previous period. Under this assumption, the household’s budget constraint (equation 5) becomes

$$c_t + i^t_t + i^i_t + \phi_x \left( i^t_t - i^t_{t-1} \right)^2 + \phi_y \left( i^i_t - i^i_{t-1} \right)^2 + T_t \leq \left( 1 - \tau^i_t \right) w_n + \left( 1 - \tau^i_t \right) r_t k_i + \tau^i_t \delta_t k_i,$$

and the market-clearing condition (equation 8) becomes

$$c_t + i^t_t + i^i_t + \frac{\phi_x}{2} \left( i^t_t - i^t_{t-1} \right)^2 + \frac{\phi_y}{2} \left( i^i_t - i^i_{t-1} \right)^2 + g_t = y_t,$$

where $\phi_x \geq 0$ and $\phi_y \geq 0$.

In what follows, we will assume that $\phi_x = 0.01$ and $\phi_y = 0.01$. These adjustment costs are quite small. To see this, consider starting from the steady state calibrated previously and doubling the amount of business investment $\bar{\bar{i}}^t$ and home investment $\bar{\bar{i}}^i$. As a fraction of total output, the associated adjustment costs turn out to be

$$\frac{\phi_x}{2} \left( \bar{\bar{i}}^t \right)^2 = 0.007\%$$

and

$$\frac{\phi_y}{2} \left( \bar{\bar{i}}^i \right)^2 = 0.005\%,$$

respectively, which are small numbers indeed.

Figure 5 reproduces the experiment that we performed in the previous section to measure the effects of EGTRRA, but subject to the small adjustment costs described here. We see that the behavior of the model economy resembles the broad features described in figure 4, but without the large swings in the investment components. We conclude that the model with adjustment costs broadly reproduces some of the activity patterns observed during the 2001 recession. During the first year after the initial steady state, the model economy goes into a recession with low levels of hours worked, output, and business investment (panels C, D, and E) but with relatively strong consumption and home investment (panels B and F). The recovery starting in the second half of 2001 seems to be too strong, though. However, this is not surprising, since the model abstracts from important subsequent shocks to the economy, such as the Enron accounting scandal and September 11 terrorist attacks, and the cyclical propagation of earlier shocks, such as the high-tech bust and the associated stock market decline of 2000.

**The 2008 presidential election**

So far we have focused on the effects of anticipated tax cuts following the 2000 presidential election. In this section, we consider the mirror image: the aftermath of the 2008 presidential election. During the 2008 presidential campaigns, the Republican candidate, John McCain, promised to make permanent the tax cuts that were implemented by the George W. Bush administration. Contrary to that campaign proposal, the Democratic candidate, Barack Obama, made it clear that, at least for high-income
individuals, he would let those tax cuts expire with the existing “sunset” provision. With Barack Obama winning the presidency in 2008 and his party retaining control of Congress, economic agents are likely to have concluded that tax rates would partly revert in 2011 to their pre-EGTRRA levels.

In what follows, we illustrate the effects of this type of *anticipated tax increase*. Since it is extremely difficult to determine what tax increases might eventually be implemented and what impact they might have on effective marginal tax rates, we make an extremely simplistic assumption: That all tax rates will

---

**FIGURE 4**

Effects of EGTRRA

<table>
<thead>
<tr>
<th>A. Tax rates</th>
<th>B. Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>index</td>
<td>index</td>
</tr>
<tr>
<td>0.33</td>
<td>103</td>
</tr>
<tr>
<td>0.34</td>
<td>101</td>
</tr>
<tr>
<td>0.35</td>
<td>100</td>
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<tr>
<td>0.36</td>
<td>99</td>
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<tr>
<td>0.37</td>
<td>99</td>
</tr>
<tr>
<td>0.38</td>
<td>98</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. Hours worked</th>
<th>D. Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>index</td>
<td>index</td>
</tr>
<tr>
<td>0.33</td>
<td>103</td>
</tr>
<tr>
<td>0.34</td>
<td>101</td>
</tr>
<tr>
<td>0.35</td>
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<td>0.36</td>
<td>99</td>
</tr>
<tr>
<td>0.37</td>
<td>99</td>
</tr>
<tr>
<td>0.38</td>
<td>98</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>E. Business investment</th>
<th>F. Home investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>index</td>
<td>index</td>
</tr>
<tr>
<td>0.33</td>
<td>103</td>
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<td>99</td>
</tr>
<tr>
<td>0.38</td>
<td>98</td>
</tr>
</tbody>
</table>

Notes: EGTRRA means the Economic Growth and Tax Relief Reconciliation Act of 2001. Panels B through F are normalized (indexed) to 100 at 2000:Q4.
revert to their pre-EGTRRA levels by 2011 and that all economic agents believe that this will be the case. While this is a highly unrealistic assumption, it will suffice for our illustrational purposes.

Specifically, we assume that in 2008:Q4 the economy was at the steady state corresponding to the low marginal tax rate on capital ($\tau_k$) of 36.41 percent and on labor ($\tau_n$) of 34.40 percent introduced by the George W. Bush administration (see fourth row of panel C in table 1, p. 21). We also assume that in 2009:Q1 economic agents find out that marginal tax rates on capital ($\tau_k$) and labor ($\tau_n$) will be permanently increased to their
pre-EGTRRA levels of 37.43 percent and 36.20 percent, respectively, starting in 2011:Q1. For comparability, we introduce the same adjustment costs considered in the previous section.

Figure 6 presents the results. We see that during 2009 and 2010 the model economy experiences a marked boost in economic activity, with hours worked and output increasing monotonically over time (panels C and D). Business investment (panel E) is strong during 2009 but weak during 2010. The opposite is true for home investment (panel F). Consumption (panel B) drops immediately because economic agents feel poorer from the higher expected tax rates. The reason for the early economic boom is that agents realize that the period before the tax

Notes: EGTRRA means the Economic Growth and Tax Relief Reconciliation Act of 2001. Panels B through F are normalized (indexed) to 100 at 2008:Q4.
increase is relatively attractive for working and investing. Once the tax increase takes place in 2011:Q1, there is a sharp drop in hours worked and output.

So, according to the model, the current recession would have been even worse in terms of hours worked and output had there not been expectations of future tax increases. However, these expectations might be contributing to the weakness in consumption and residential investment that we currently see. The model expects a further downward influence on economic activity in 2011 once tax rates are increased.

**Conclusion**

In this article, we used a stylized model economy to investigate the hypothesis that some of the unusual features of the 2001 recession may have been influenced by the tax cuts promised during the 2000 presidential campaigns. We found that the model is consistent with this hypothesis: In the model economy, anticipated tax cuts generate a mild recession with relatively strong consumption and home investment, but with weak hours worked and business investment. Because the 2008 presidential election also had a significant impact on future tax rates, but in reverse, we also used our model to illustrate the possible effects on the economy of anticipated future tax increases. Both of these applications illustrate a more basic result in economic theory: That anticipated future changes in economic policy might have large effects on current economic activity.

**NOTES**

1. The argument that expected tax cuts one year down the road decrease investment during the current year is based on the assumption that investment affects the stock of capital rather quickly (say, within one quarter). If there were long gestation lags in building capital, anticipated tax cuts in one year may actually increase investment during the current year. The assumption that capital is quickly built will be maintained throughout this article.


3. The source of all data unless otherwise specified is the U.S. Bureau of Economic Analysis.

4. The CBO simulated income tax liability for each return in a sample of all tax returns filed in the United States. The analysis then calculated marginal tax rates by adding $1,000 to the earnings on each return and recomputing the amount of income tax owed. The difference between the two tax liabilities, divided by $1,000, equals the effective marginal tax rate.

5. Our effective marginal tax rates on capital are roughly twice as large as the CBO’s estimates, since our notion of capital does not include residential structures, while the CBO’s does. See the appendix for a brief discussion regarding the treatment of housing capital.

6. Among other things, this implicitly assumes that the AMT is changing in a similar way.

7. By allowing for lump-sum taxes, the optimal tax system is to set the capital and labor income taxes to zero and rely exclusively on lump-sum taxes. However, the focus of our analysis is not on optimal taxation but on the effects of actual tax rates.

8. Although the 2000 election outcome may have had implications for prospective government expenditures, we abstract from these.

9. Observe that we are assuming that government expenditures are unproductive. However, this could be modified without altering the analysis by assuming that government expenditures enter the utility function in a separable way.

10. Observe that there is no rental market for home capital: All home capital is directly owned by the household sector. This is a limitation of the model economy. In practice, a significant fraction of residential structures are rented, and the income generated is subject to taxes. Another limitation of the model is that the stock of home capital is not taxed at all, although in the U.S. economy, housing is subject to property taxes.

11. Since ours is a closed economy, the measure of output that we use is GDP minus net exports.

12. The implied Frisch elasticity of labor supply is equal to 2.7. This is somewhat lower than the Frisch elasticity of labor supply used by Prescott (2004) in his cross-country analysis of labor income taxes but much higher than econometric estimates based on microeconomic data. However, recent research has shown that the large elasticity of labor supply used by the macro literature can be reconciled with the micro evidence through heterogeneity in labor supply (for example, Chang and Kim, 2006; Rogerson and Wallenius, 2009; and Gourio and Noual, 2007).

13. We make no claim that these adjustment costs are empirically plausible. However, they improve the model’s performance quite significantly.

14. The investment measures reported in figure 5 (p. 29) include the adjustment costs. However, in practice this does not matter because the adjustment costs are extremely small.
When the Congressional Budget Office (2001) estimates the effects of EGTRRA on effective marginal tax rates for labor and capital income, it includes residential structures in its notion of capital. Because owner-occupants of residential structures “exclude their implicit gross receipts (i.e., the rental value of the home) from taxable income ... and may deduct mortgage interest and property tax payments if they itemize their deductions,” the CBO concluded that owner-occupied housing capital is subsidized (Congressional Budget Office, 2005). Since this subsidy is not given to tenant-occupied housing capital, the CBO concluded that this form of capital is taxed. Using the CBO’s estimates of the effective tax rates on both tenant-occupied (18.2 percent) and owner-occupied (−5.1 percent) housing capital income, as well as the proportion of each type of capital in total housing capital, we obtain that the “housing capital income tax rate” $\tau^h$ is given as follows:

\[
\tau^h = \left( \frac{\text{(% Tenant-occupied housing)}}{2} \times 0.182 \right) + \left( \frac{\text{(% Owner-occupied housing)}}{2} \times (-0.051) \right) = (0.20) \times (0.182) + (0.80) \times (-0.051) = -0.0044 - 0.0044 = 0.
\]

Since the services from consumer durables are not taxed and $\tau^s = 0$, we have that the effective marginal tax rate on capital income estimated by the CBO is equal to:

\[
\tau_{\text{CBO}}^k = \frac{k}{k+d} \times \tau^k + \frac{d}{k+d} \times 0,
\]

where $k$ represents business capital and $d$ represents home capital.

Using the average ratio $(k + d) / k$ over the period 1998–2003, we have that the tax rate on business capital income is then given by:

\[
\tau^k \equiv \frac{\text{CBO}}{k} \times \frac{k + d}{d} \approx 0.182 \times (2.0456) \approx 0.3743.
\]

The fractions of each type of housing capital are obtained from Congressional Budget Office (2005), p. 19, table A-1.

**REFERENCES**


